

DIAGNOSTIC INVESTIGATION IN RESPIRATORY SYSTEM

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DIAGNOSTIC PROCEDURES IN RESPIRATORY DISEASES.

NONINVASIVE PROCEDURES:

- radiographic procedures,
- sputum examination,
- pulmonary function tests

INVASIVE PROCEDURES:

- skin tests,
- serologies tests
- Arterial Blood Gas
- D- Dimer / FDP

SPECIAL PROCEDURES:

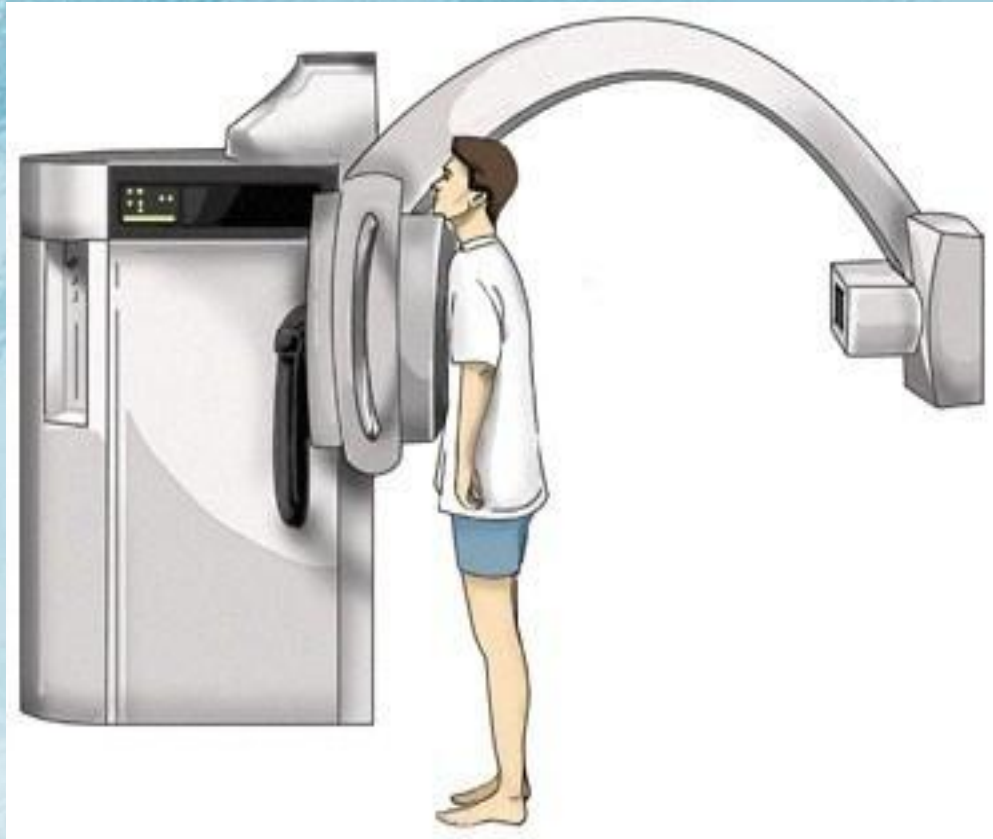
- bronchoscopy,
- bronchography,
- bronchoalveolar lavage,
- thoracentesis,
- pleural biopsy,
- thoracoscopy,
- pulmonary and bronchial angiography
- lung biopsy

NONINVASIVE PROCEDURES:

RADIOGRAPHIC PROCEDURE

- X- Ray
- CT Scan
- MRI
- PULMONARY AND BRONCHIAL
ANGIOGRAPHY

Chest X-Ray

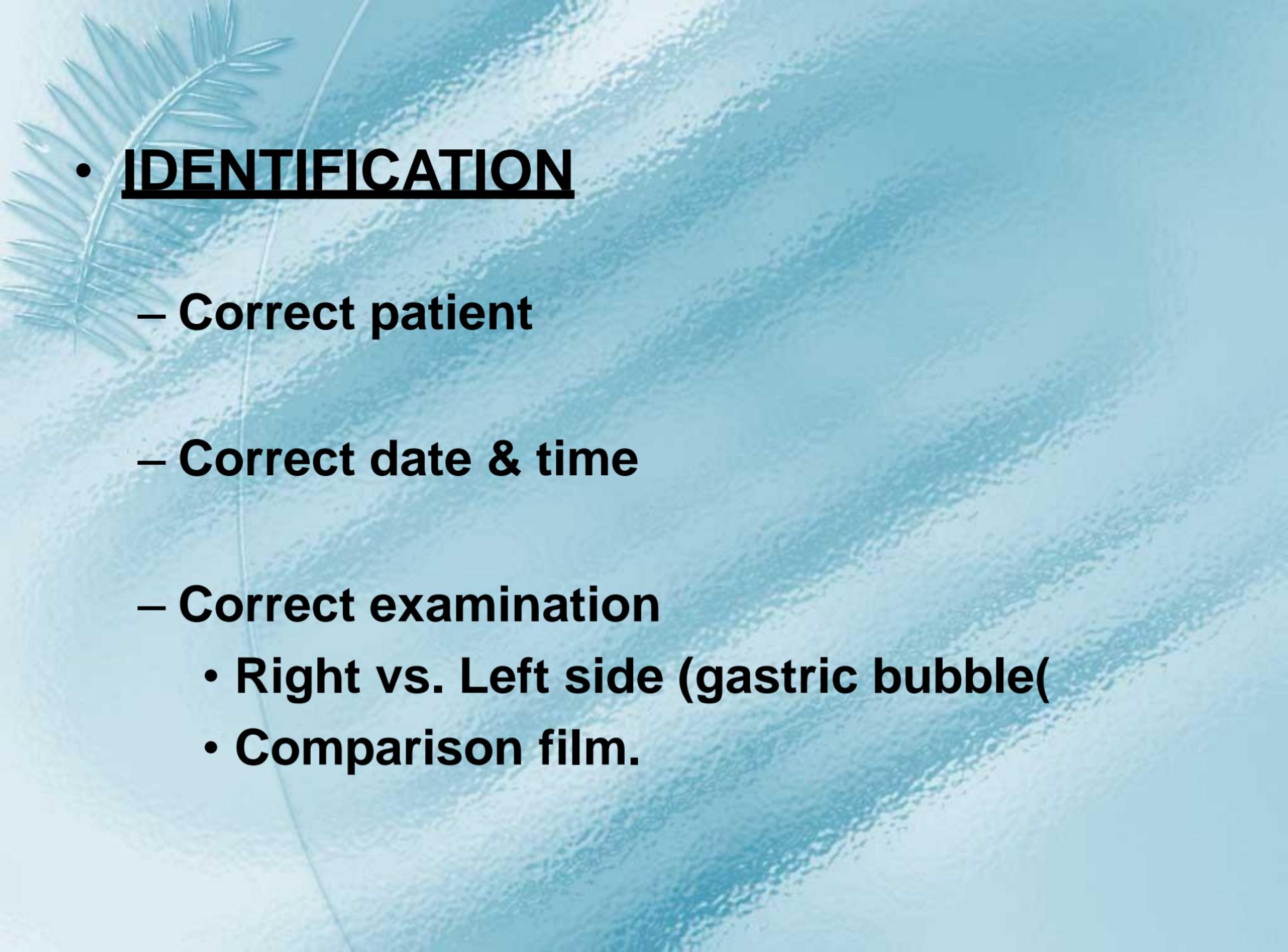






Systematic CXR Interpretation

- **IDENTIFICATION**
- **TECHNIQUE**
- **INTERPRETATION**



- **IDENTIFICATION**

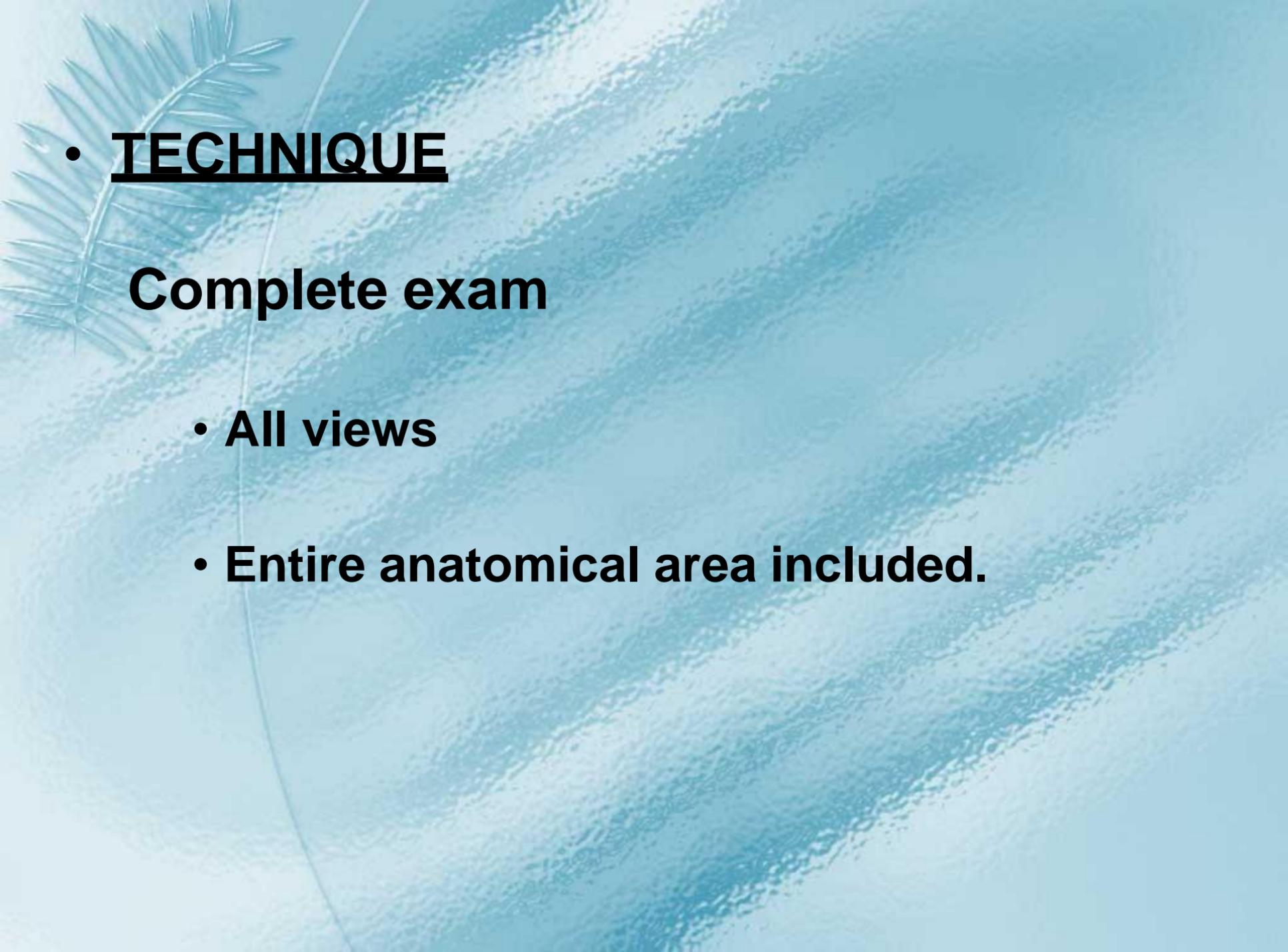
- **Correct patient**

- **Correct date & time**

- **Correct examination**

- **Right vs. Left side (gastric bubble(**

- **Comparison film.**



- **TECHNIQUE**

- Complete exam**

- **All views**
- **Entire anatomical area included.**

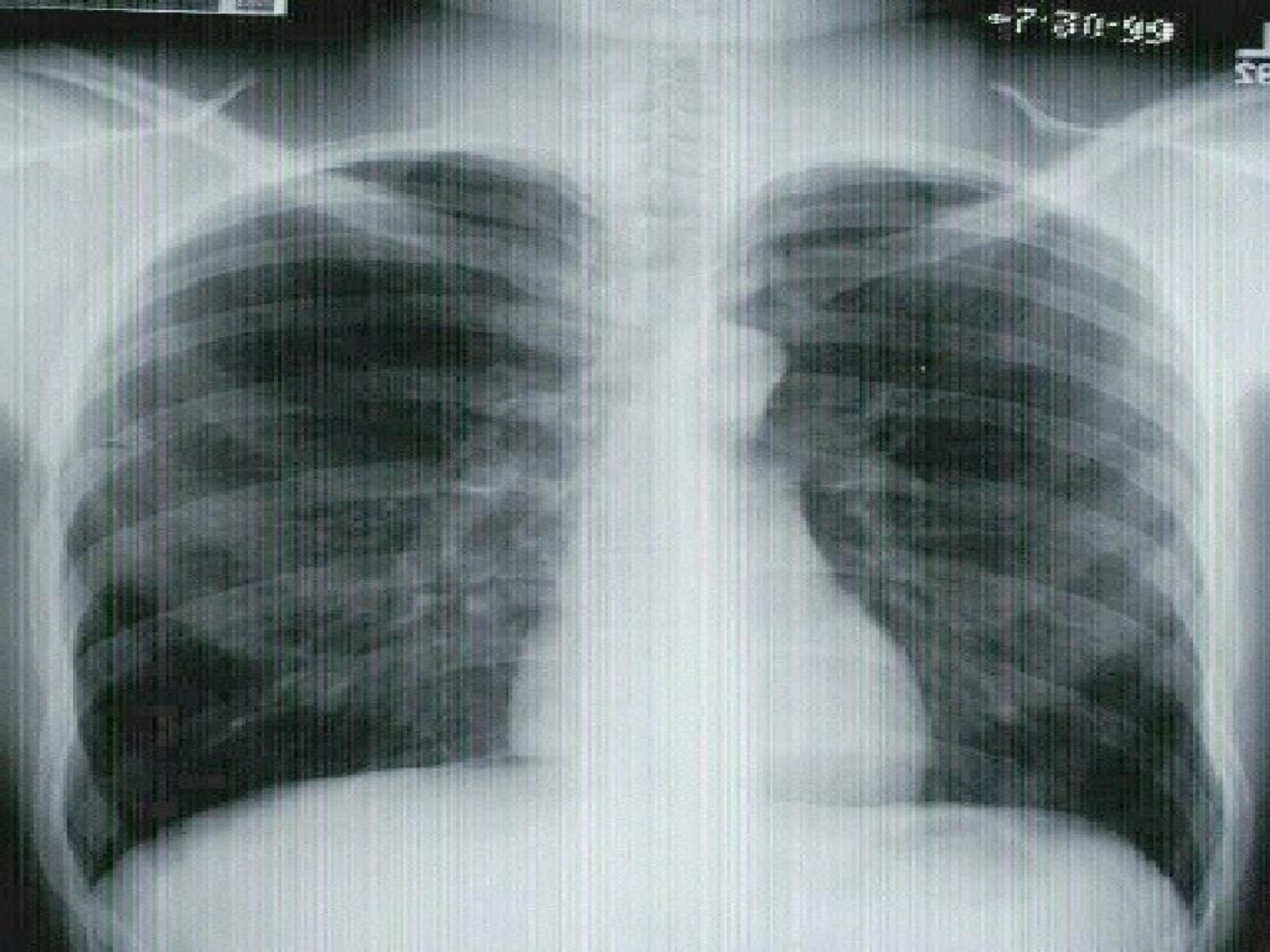
TECHNIQUE

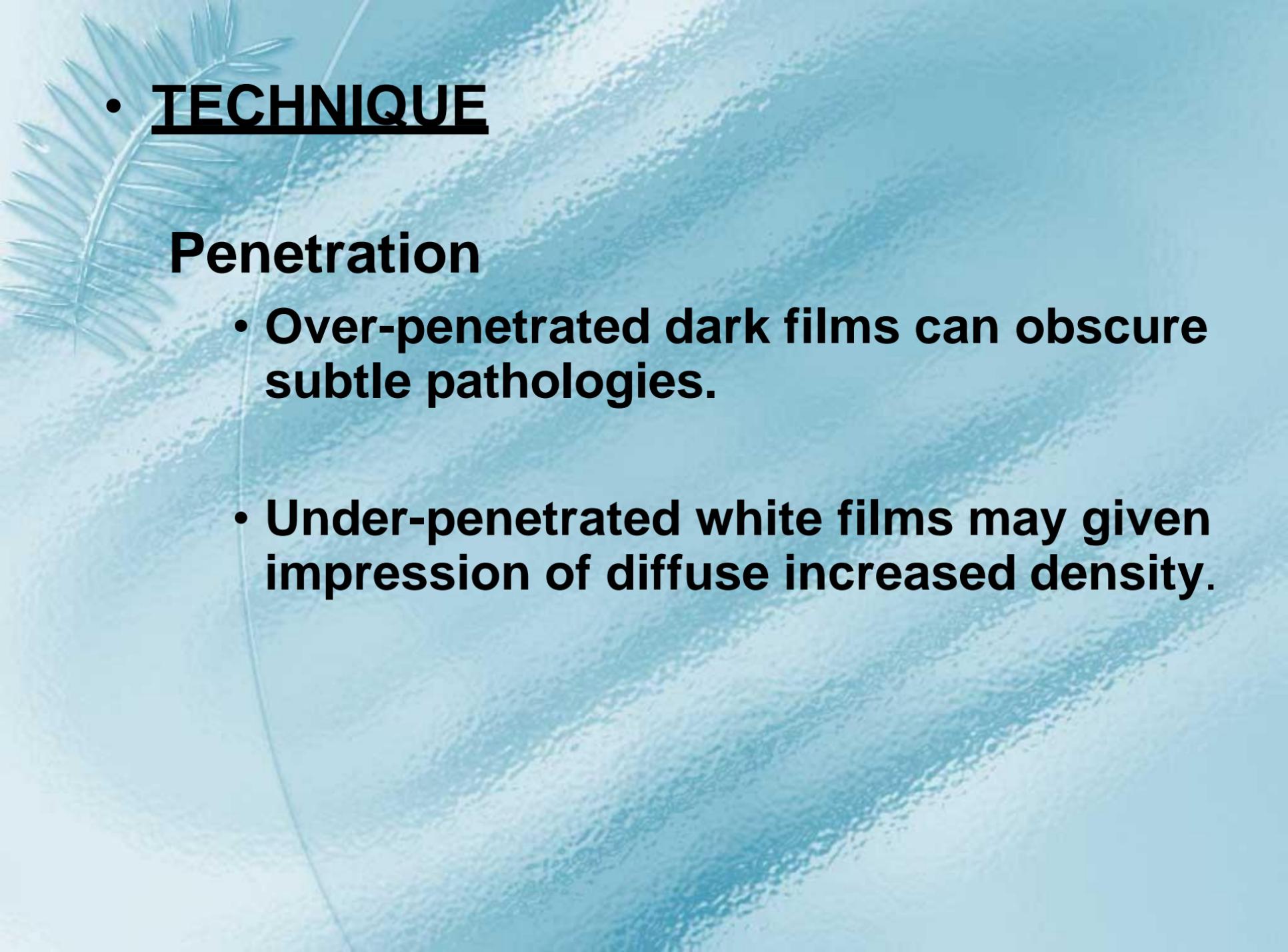
Projection or Quality of the film:

- First determine is the film a **PA** or **AP** view.
- **PA**- the x-rays penetrate through the back of the patient on to the film.
- **AP**-the x-rays penetrate through the front of the patient on to the film.

The width of heart & mediastinum larger on AP film.

- **All x-rays in the ICU are portable and are AP view**





- **TECHNIQUE**

Penetration

- **Over-penetrated dark films can obscure subtle pathologies.**
- **Under-penetrated white films may given impression of diffuse increased density.**

OVER OR UNDER PENETRATED

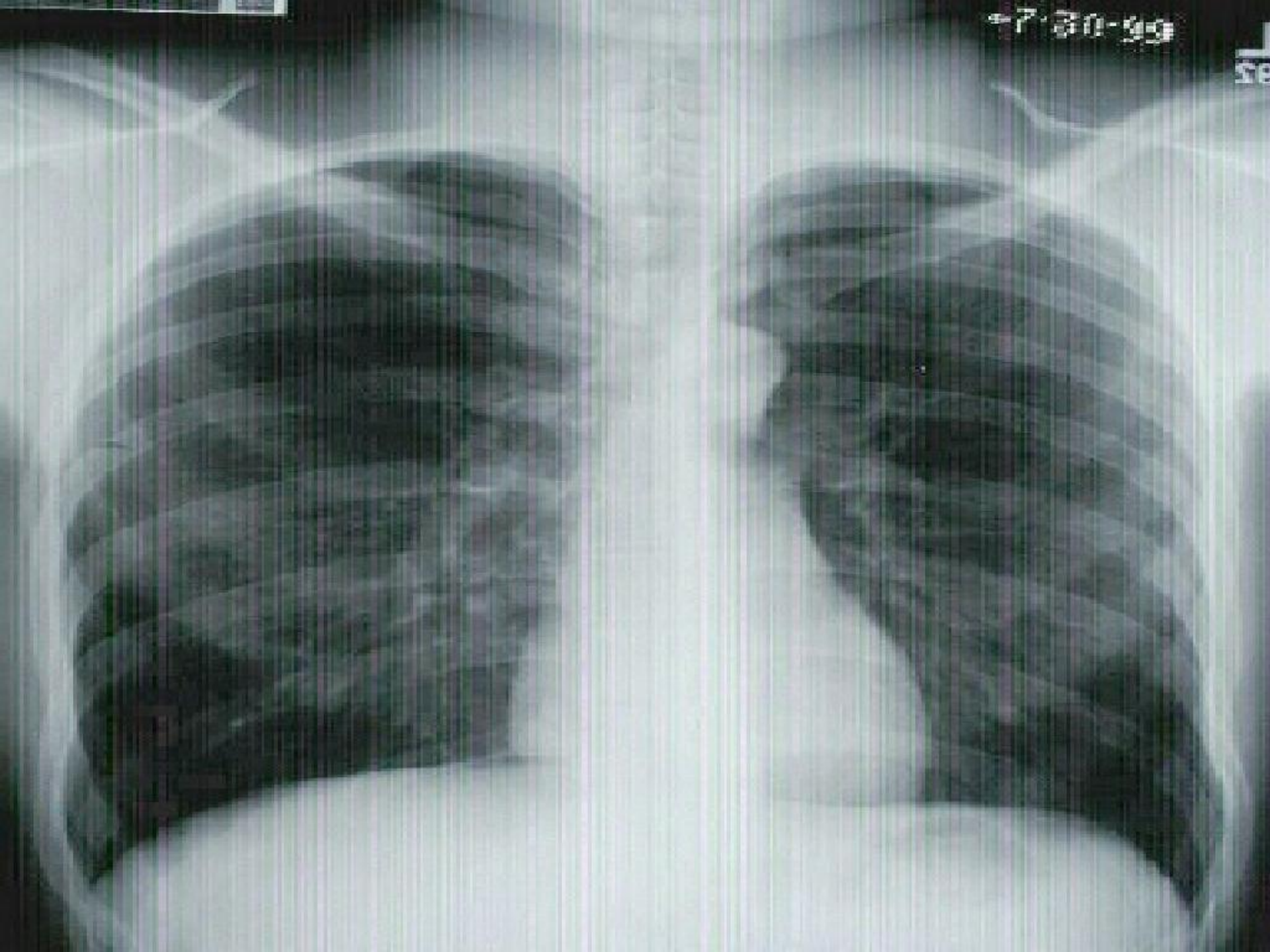
- If under penetrated you will ***not*** be able to see the thoracic vertebrae.



- **TECHNIQUE**

Adequacy (full Inspiration)

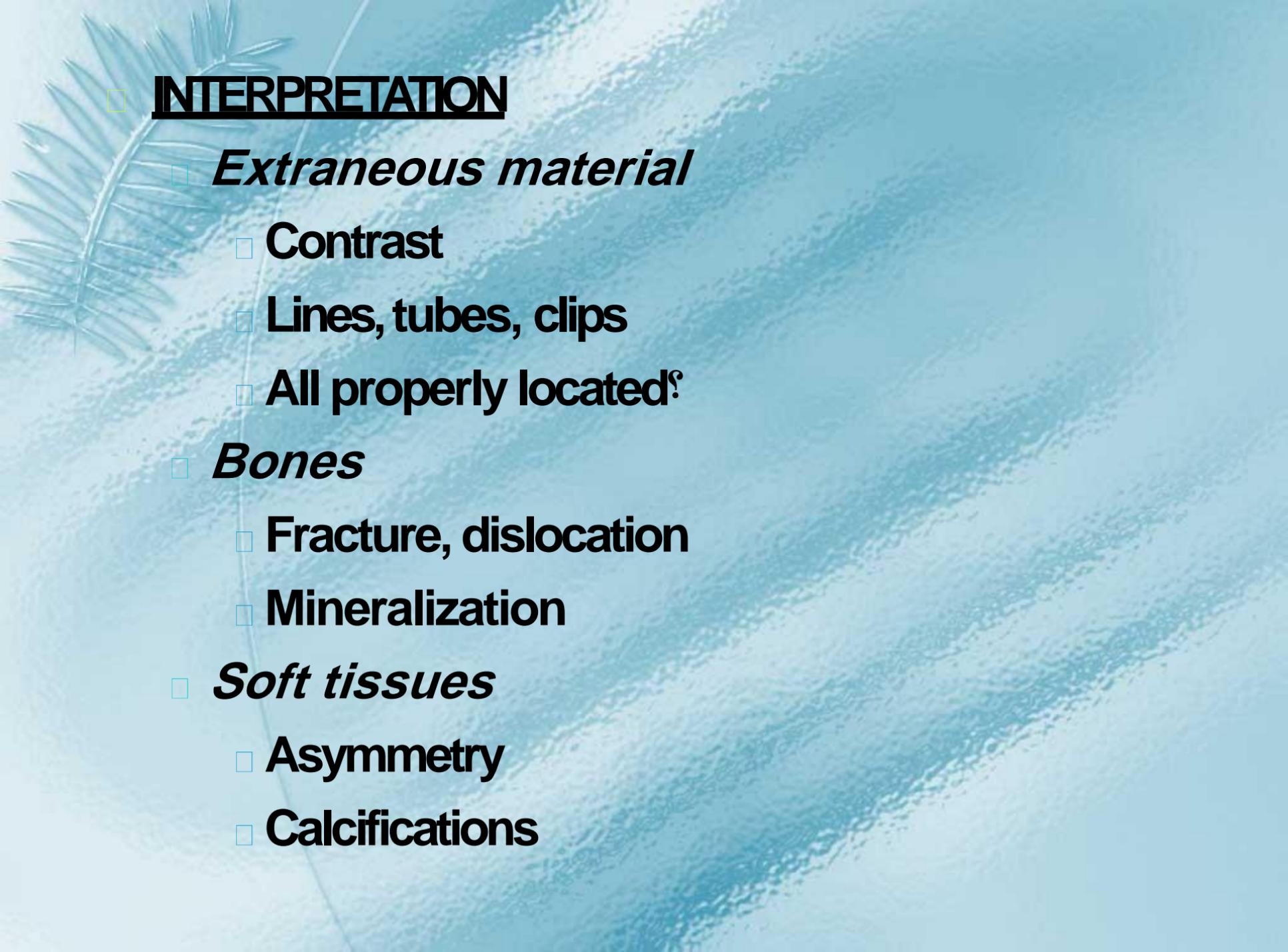
- Normal, erect, inspiratory CX-Ray shows -9.5 to 10.5 posterior ribs.
- Less inspiration appears diffusely denser
- Diaphragms elevated causing heart & mediastinum to appear enlarged.



- **TECHNIQUE**

Rotation

- Determine by observing the equal distance between the ***medial clavicular head*** and the ***spinous process*** of the thoracic vertebral body.



- **INTERPRETATION**

- ***Extraneous material***

- **Contrast**

- **Lines, tubes, clips**

- **All properly located?**

- ***Bones***

- **Fracture, dislocation**

- **Mineralization**

- ***Soft tissues***

- **Asymmetry**

- **Calcifications**



- ***Diaphragms & Below***

- **Free air**

- **Dilated bowel**

- **Abnormal position**

- ***Lung fields & mediastinum***

- **Asymmetry , central mediastinum**

- **Consolidation (opacity), nodule or lesion**

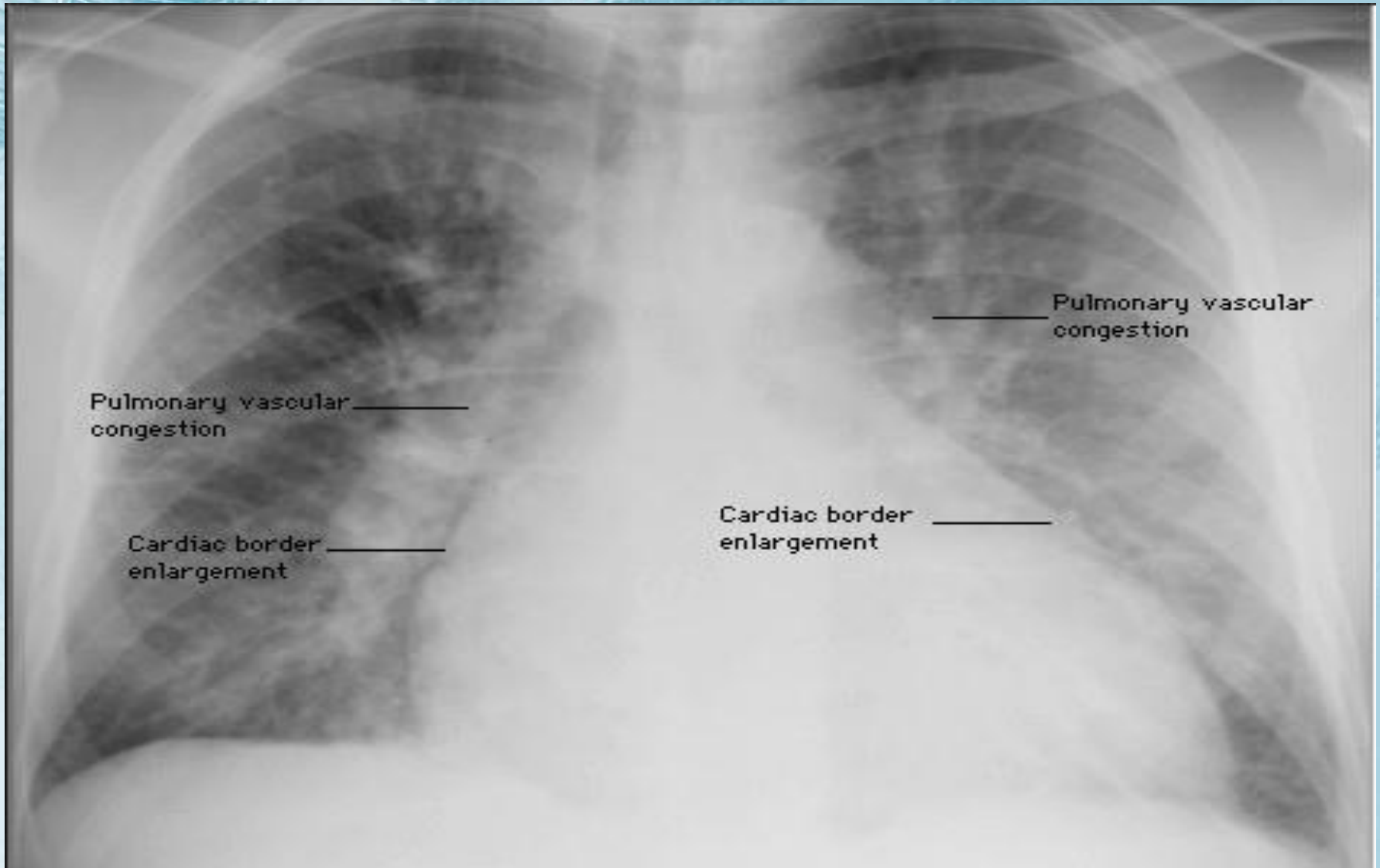
- **Vascular marking.**

- ***Heart***

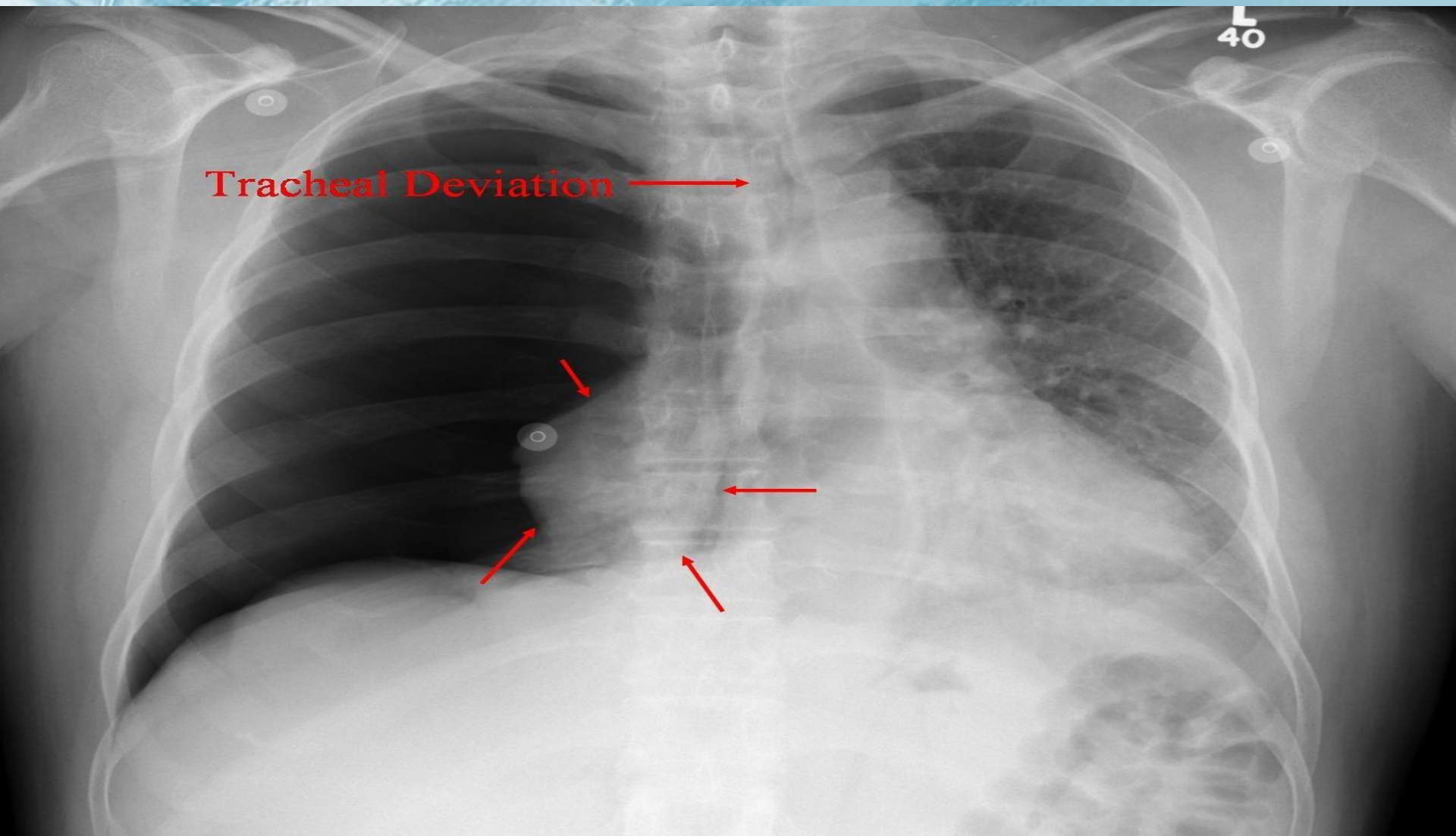
- **Size & shape**

- **Cardiothoracic ratio**

CONGESTIVE HEART FAILURE



TENSION PNEUMOTHORAX



CT Scan



INDICATIONS

- To assess equivocal plain X-ray findings
- Staging of lung neoplasms
- Metastatic workup of extrathoracic malignancies
- Diagnosis of diffuse lung disease with HRCT
- Assessment of bronchiectasis
- Assessment of suspected post-traumatic complications
- Diagnosis of mediastinal and chest wall lesions
- Diagnosis of suspected pulmonary embolism

SCANNING TECHNIQUES

- Standard Examination
- High resolution [HRCT]



MAGNETIC RESONANCE IMAGING

- MRI has the advantage that radiation is avoided. Its main indications are visualisation of the great vessels and the heart.
- It also useful with suspected tumor invasion of the mediastinum and the chest wall.

Ultrasound

Ultrasound is used to assess the pleural space for pleural fluid, which appears as a hypoechoic space. It also allows direct visualisation of the diaphragm and solid organs such as the liver, spleen and kidneys, thereby allowing safe pleural aspiration, biopsy and intercostal chest drain insertion. Ultrasound can also be used to guide needle biopsy of superficial lymph node or chest wall masses and provides useful information on the shape and movement of the diaphragm.

Endobronchial ultrasound (EBUS) is . using a specialised bronchoscope, allows directed needle aspiration from peribronchial nodes and is used increasingly to determine disease extent.

It used also for medistinal lymph node biopsy

PULMONARY AND BRONCHIAL ANGIOGRAPHY

- Pulmonary angiography and bronchial angiography (together with bronchial artery embolisation for the treatment of hemoptysis) are invasive techniques for imaging vessels and are only used if less invasive technique (contrast CT/ MRI) fail or need to be confirmed.

POSITRON EMISSION TOMOGRAPHY

(PET)

PURPOSE AND DESCRIPTION

- test, when used to examine the lungs, is performed to identify lung nodules (cancers). The client is given a radioactive substance and cross-sectional images are displayed on a computer. Radiation from PET is only 25% of that from a CT scan.

RELATED NURSING CARE

- No alcohol, coffee, or tobacco is allowed for 24 hours prior to the test. Encourage increased
- fluid intake post-test to help eliminate the radioactive material.

PULMONARY ANGIOGRAPHY

PURPOSE AND DESCRIPTION

- pulmonary emboli, tumors, aneurysms, vascular changes associated with emphysema, and pulmonary circulation. A catheter is inserted into the brachial or femoral artery, threaded into the pulmonary artery, and dye is injected. ECG leads are applied to the chest for cardiac monitoring. Images of the lungs are taken.

RELATED NURSING CARE

- Monitor injection site and pulses
- distal to the site after the test.

PULMONARY VENTILATION/PERFUSION SCAN (V/Q SCAN)

PURPOSE AND DESCRIPTION

This test is performed with two nuclear scans to measure breathing (ventilation) and circulation (perfusion) in all parts of the lungs.

A perfusion scan is performed by injecting radioactive albumin into a vein and scanning the lungs. A ventilation scan is performed by scanning the lungs as the client inhales radioactive gas. A decreased uptake of radioisotope during the perfusion scan indicates a blood flow problem, such as from a pulmonary embolus or pneumonitis.

A decreased uptake of gas during the ventilation scan may indicate airway obstruction, pneumonia, or chronic pulmonary obstructive disease (COPD.)

RELATED NURSING CARE

No special preparation is needed.

The background is a light blue gradient with darker, textured brushstrokes in a darker blue shade. In the top-left corner, there is a faint, stylized illustration of a fern frond. A thin, dark blue curved line starts near the top-left and arcs towards the bottom-left.

BLOOD TEST



ARTERIAL BLOOD GAS

Definition

- Blood gases is a measurement of how much oxygen (O_2) and carbon dioxide (CO_2) is in your blood.
- It also determines the acidity (pH) of your blood.



NORMAL VALUES

Variable	Normal Range
pH	7.45 - 7.35
pCO ₂	45-35
Bicarbonate	26-22
Anion gap	14-10
Albumin	4

PRIMARY DISORDER

What disorder is present?

pH

pCO₂ or HCO₃

Respiratory Acidosis

pH low



pCO₂ high



Metabolic Acidosis

pH low



HCO₃ low



Respiratory Alkalosis

pH high



pCO₂ low



Metabolic Alkalosis

pH high



HCO₃ high



Arterial Blood Gas

- ☐ Usually, blood is taken from an artery.
- ☐ The blood may be collected from the radial artery in the wrist, the femoral artery in the groin, or the brachial artery in the arm.
- ☐ May test circulation to the hand before taking a sample of blood from the wrist area.
- ☐ Insert a small needle through the skin into the artery.

RISKS

- ☐ Bleeding at the puncture site
- ☐ Blood flow problems at puncture site (rare)
- ☐ Bruising at the puncture site
- ☐ Delayed bleeding at the puncture site
- ☐ Fainting or feeling light-headed
- ☐ Hematoma (blood accumulating under the skin)
- ☐ Infection (a slight risk any time the skin is broken)

WHITE CELL COUNT

- Usually high (but may be normal) in pneumonia and pulmonary infection.
- Low with viral infection or severe sepsis
- Neutrophil count high in bacterial infection
- Low lymphocyte count may point to viral infection
- $4.0 > \text{or} > 12$ indicates SIRS/sepsis should improve as pneumonia resolves

Haemoglobin (Hb(

- Can get a Coombs positive haemolytic anaemia with Mycoplasma pneumonia

Blood film

- Platelets can increase or decrease with infection (reactive thrombocytosis)
- May be low with severe sepsis

POTASSIUM

Low potassium (hypokalaemia) may suggest **legionella pneumonia**

* Low potassium also seen with IV piperacillin-tazobactam, steroid therapy and nebulised salbutamol

Calcium : elevated in granulomatous diseases, CA

LIVER PROFILE

“liver function tests”

Raised ALT, GGT and alkaline phosphatase not unusual in patients with viral pneumonia and atypical pneumonia.

C reactive protein (CRP)

- “acute phase reactant”
- Usually high with acute infection, and falls as infection improves
- Good marker of improvement

Immunological and serological tests

The presence of pneumococcal antigen (revealed by counter immunoelectrophoresis) in sputum, blood or urine may be of diagnostic importance in pneumonia.

Influenza viruses can be detected in throat swab samples by fluorescent antibody techniques.

In blood, high or rising antibody titres to specific organisms (such as *Legionella*, *Mycoplasma*, *Chlamydia* or viruses) may eventually clinch a diagnosis suspected on clinical grounds but early diagnosis of *Legionella* is best done by urine antigen testing.

Precipitating antibodies may indicate a reaction to fungi such as *Aspergillus* or to antigens involved in hypersensitivity pneumonitis .

Total levels of immunoglobulin E (IgE), and levels of IgE directed against specific antigens, can be useful in assessing the contribution of allergy to respiratory disease

Alpha 1 Antitripsin level

- Genetic deficiency
- Alpha 1 antitripsin deficiency causes early onset emphysema
- Can be given replacement therapy
- Blood tests specific to COPD in young patient .

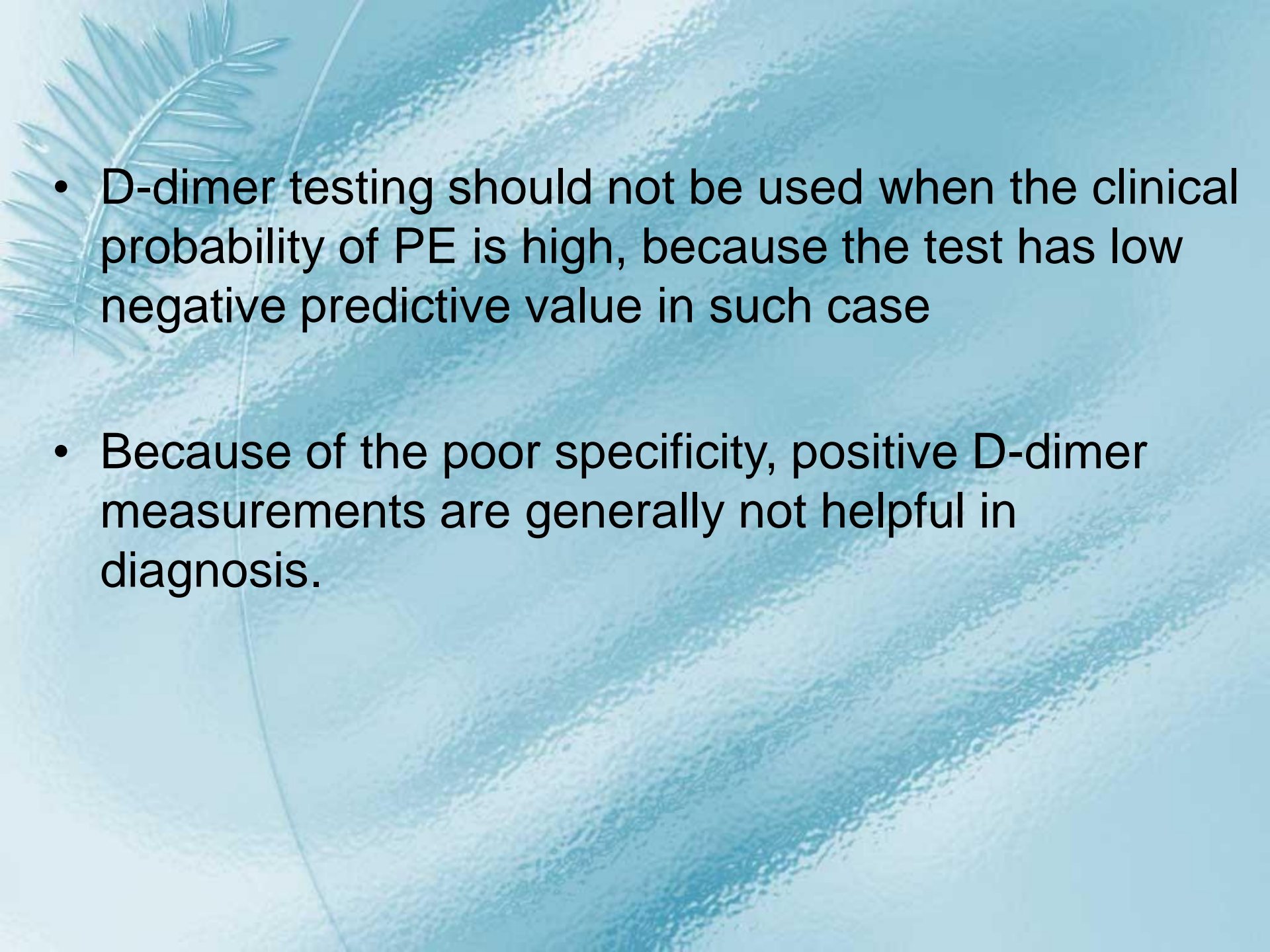


Angiotensin-converting enzyme (ACE)

Diagnosis of sarcoidosis.

D-dimer

- When clinical prediction rule results indicate that the patient has a low or moderate pre-test probability of pulmonary embolism, D-dimer testing is the usual next step.
- Negative results on a high-sensitivity D-dimer test in a patient with a low pretest probability of PE indicate a low likelihood of venous thromboembolism and reliably exclude.

- 
- D-dimer testing should not be used when the clinical probability of PE is high, because the test has low negative predictive value in such case
 - Because of the poor specificity, positive D-dimer measurements are generally not helpful in diagnosis.



Quantiferon test

Alternative for mantoux test in TB
diagnosis .

Skin tests

The tuberculin test

may be of value in the diagnosis of tuberculosis.

Skin hypersensitivity tests

are useful in the investigation of allergic diseases

SPUTUM EXAMINATION

- **SPUTUM CULTURE-**

It is helpful in detecting the organism responsible for infection e.g. VAP.

- **ACID FAST BACILLI :-**

good investigation for T.B

- **Sputum esinophils
count**



SPECIAL TEST

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THORACENTESIS

Chest Tubes Indications

- Pneumothorax
 - Tension
 - Spontaneous
 - Iatrogenic
 - consider while on mechanical ventilation
- Hemothorax
- Empyema
- Bronchopleural fistulas

Pneumothorax



CHEST TUBE SIZE

- **Pneumothorax** — A 16 to 24 Fr chest tube.
- **Traumatic pneumothorax** — 28 to 40 Fr chest tube
 - drainage of blood in addition to air may be necessary.
- **Malignant effusion** — A 20 to 24 Fr chest tube
- **Empyema** — 28 to 36 Fr chest tube
 - May need more than one tube for loculated areas
- **Hemothorax** — 32 to 40 Fr chest
 - Larger caliber helps prevent occlusion

COMPLICATIONS

- Lung parenchyma perforation
- Subcutaneous tube placement
- Perforation of the ventricle or atrium, and abdominal organs (spleen, liver, stomach, colon)
 - cardiogenic shock from chest tube compression of the right ventricle
 - Mediastinal perforation with contralateral hemothorax and pneumothorax
 - bleeding from intercostals artery injury
 - infection at the chest tube site

COMPLICATIONS

- Pain at the puncture site
- Pneumothorax ((12-30%
- Empyema
- Soft tissue infection
- Spleen or liver puncture
 - Make sure sitting upright
- Seeding the needle tract with tumor

The background is a light blue gradient with darker, textured brushstrokes in a diagonal pattern. In the top-left corner, there is a faint, stylized illustration of a fern frond. A thin, dark, curved line starts near the top-left and arcs downwards towards the bottom-left.

BRONCHOSCOPY

EQUIPMENT

A bronchoscope is an instrument about 3ft long and 0.5 ins or smaller in diameter that combines four narrow chambers into one tube

- One lumen contains a fiber-optic light source.
- 2nd chamber lumen is attached to a suction device & airway secretions can be removed.
- 3rd chamber has tiny metallic alligator forceps that can be extended past the proximal end for tissue biopsies.
- 4th chamber lumen allows passage of a small wire brush that can be passed vigorously over airway structures for collection of tissue cells for microscopic evaluation

Flexible versus rigid bronchoscopy

Flexible bronchoscopy

is usually performed under local anaesthesia with sedation, on an outpatient basis.

Rigid bronchoscopy

requires general anaesthesia and is reserved for specific situations, such as massive haemoptysis or removal of foreign bodies

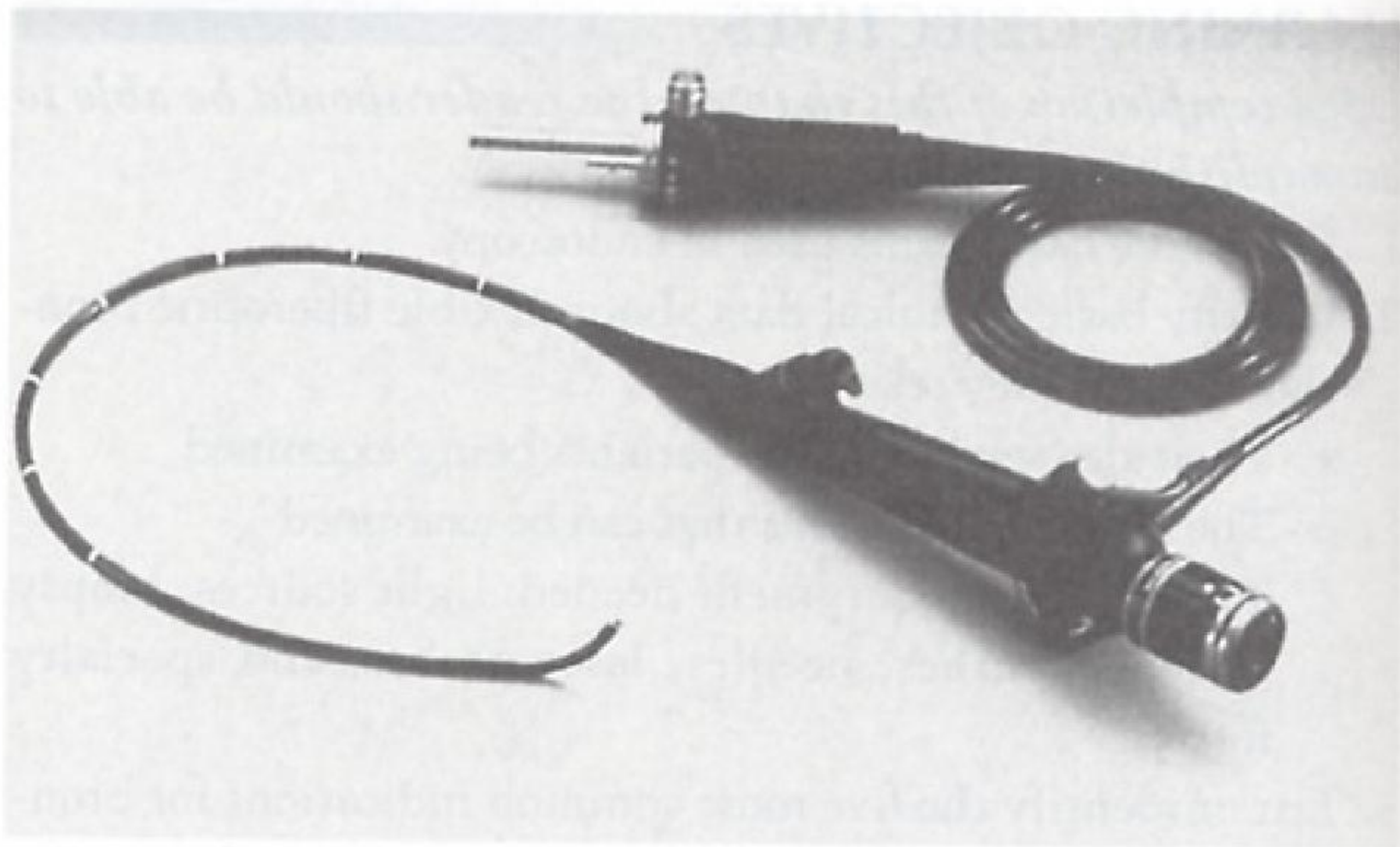


Figure 16-1 Standard flexible fiberoptic bronchoscope. The attachment for a light source is seen at the top of the photo. (Courtesy Olympus America Inc, Melville, NY.)

INDICATIONS

- **Diagnostic**
 - Suspected foreign body
 - Suspected malignancy
 - Bronchial washings
 - Hemoptysis
 - Persistent problems
- **Therapeutic**
 - Foreign-body obstruction
 - Secretion removal
 - Bronchial lavage
 - Stenosis
 - atelectasis

BOX 16-1 Indications for Flexible Bronchoscopy

Abnormal chest roentgenogram

- New or persistent shadow suggesting neoplasia

- Slowly resolving pneumonia

- Persistent atelectasis

- Unexplained and persistent pleural effusion

- Unexplained and persistent paralysis of a hemidiaphragm

- Interstitial fibrosis

Hemoptysis

Pneumonia

- Identification of causative organism

- Immunocompromised patients

Therapeutic

- Atelectasis (to remove mucus plugs and secretions)

- Laser excision of obstructing neoplasms

- Removal of foreign bodies

- Lung lavage in alveolar proteinosis

Unexplained and persistent cough or wheeze (stridor)

Tracheal disease (posttracheostomy)

Intensive care unit uses

- Difficult intubations

- Suctioning while patient is on a ventilator

Miscellaneous

- Unexplained hoarseness

- Brachytherapy (installing small radioactive “seeds” directly into tumor masses)

- Evaluation for possible upper airway burns and swelling in burn patients

- Bronchography

- Research (bronchoalveolar lavage)

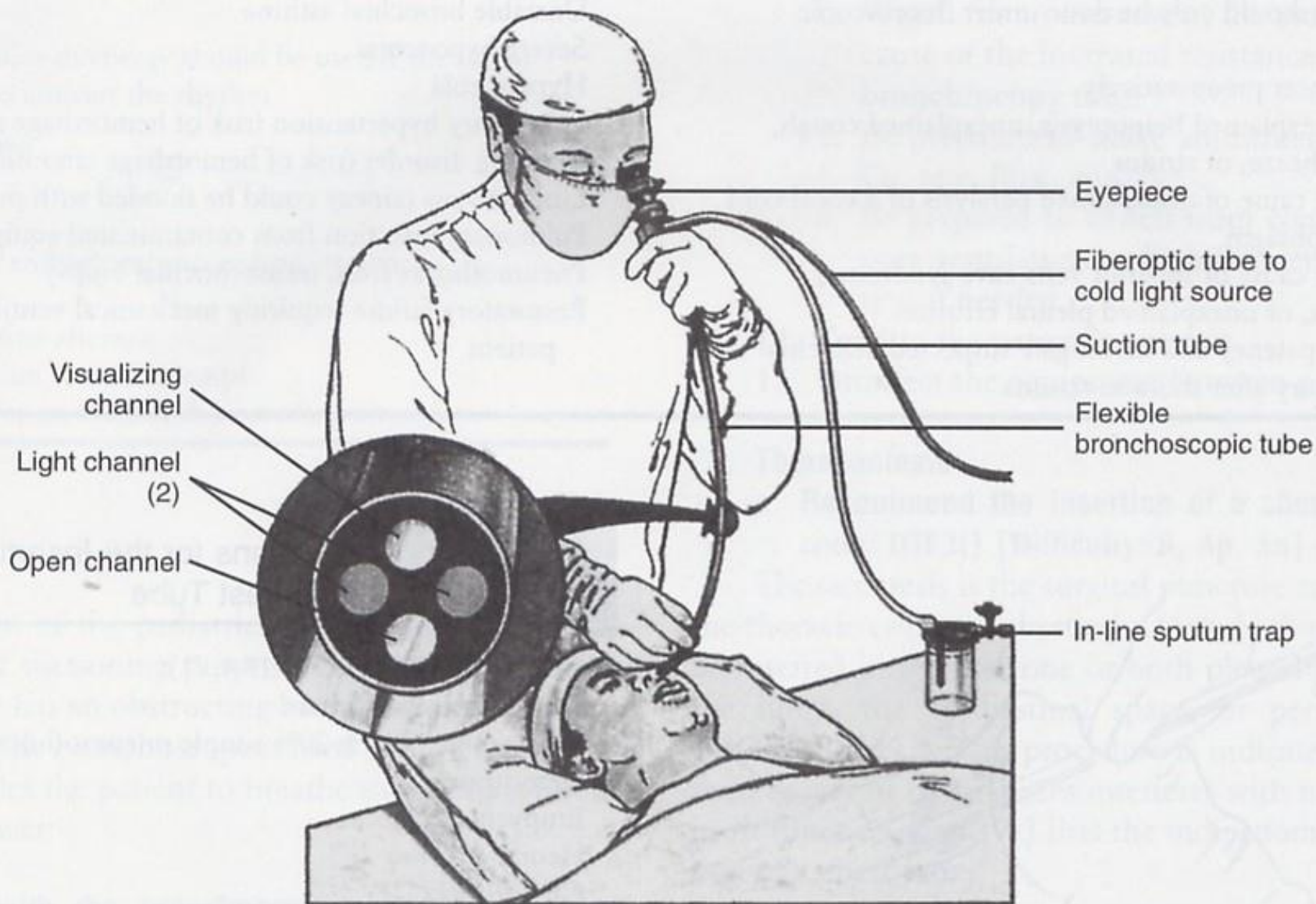


Fig. 17-3 A flexible fiberoptic bronchoscopy being performed on a patient. (From Williams SF, Thompson JM: *Respiratory disorders*, St Louis, 1990, Mosby.)

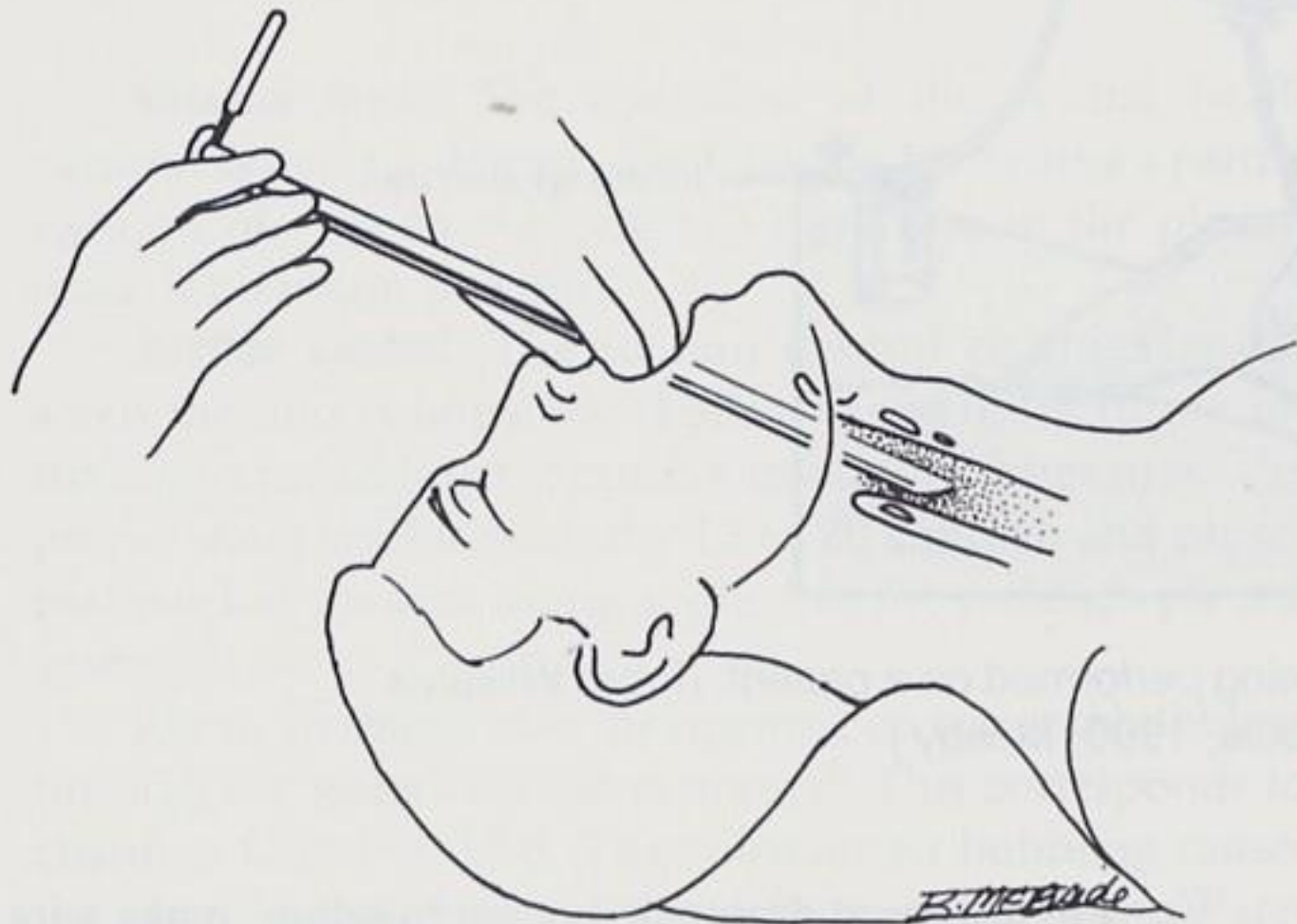


Fig. 17-1 Rigid tube bronchoscope being inserted into a patient's trachea. Note how the head and neck must be hyperextended. (From Scanlan CL, Simmons KF: Airway management. In Scanlan CL, Wilkins RL, Stoller JK, editors: *Egan's fundamentals of respiratory care*, ed 7, St Louis, 1999, Mosby.)



Figure 16-6 Lateral neck radiograph of a rigid bronchoscope tube in place. (From Stradling P: *Diagnostic bronchoscopy*, ed 6, New York, 1991, Churchill Livingstone.)



Hazards and complications

- Most common complication is mild epistaxis.
- Bronchospasm or laryngospasm
 - From irritation of the airway
- Bleeding
- Hypoxemia
- Arrhythmias
 - From vagal stimulation. Monitor ECG and remove scope until cardiac status is stabilized
- Seizures
- Aspiration
- Pneumothorax
- Respiratory depression

BOX 16-2

Complications of Flexible Bronchoscopy

Premedication

- Respiratory failure

- Hypotension

- Hyperexcitement

Local anesthesia

- Laryngospasm

- Bronchospasm

- Seizures

- Cardiopulmonary arrest

- Methemoglobinemia

Bronchoscopy

- Bronchospasm or laryngospasm

- Hypoxemia

- Cardiac arrhythmias

- Aspiration

During biopsy

- Pneumothorax

- Bleeding

- Loss of biopsy tip

Postprocedure

- Persistent bleeding

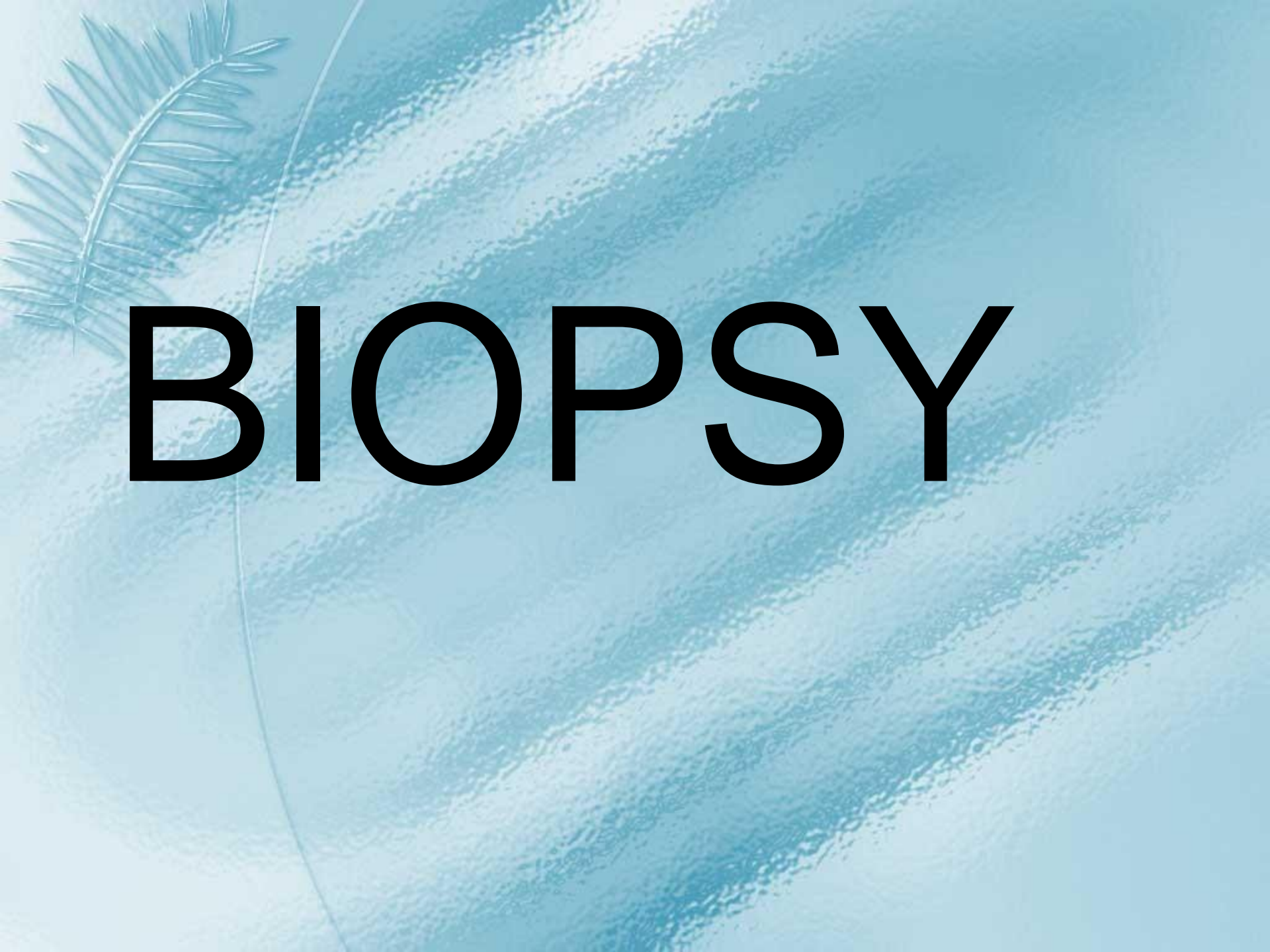
- Fever

- Pneumonia

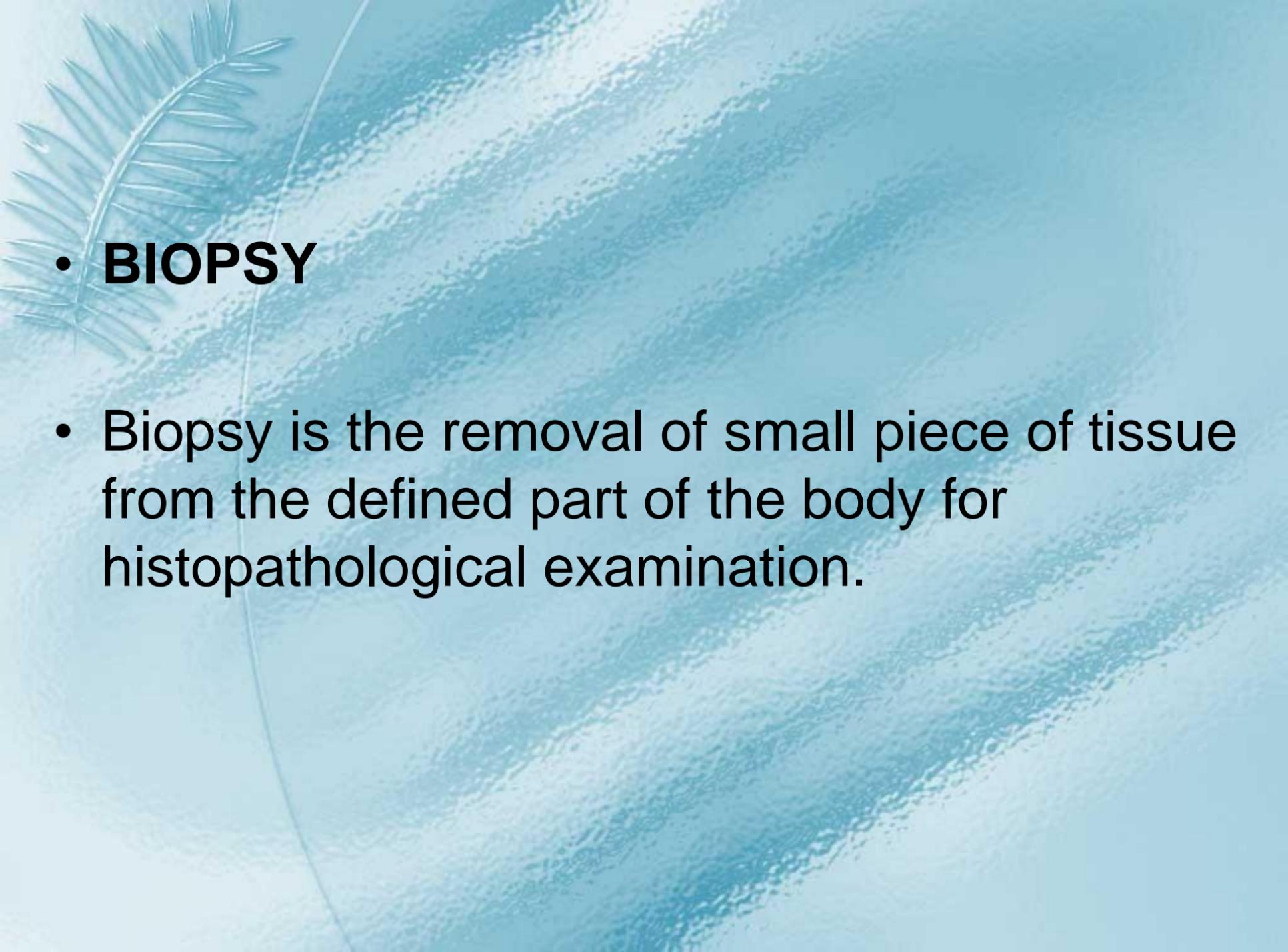


Contraindications

- Refractive hypoxemia
- Bleeding disorders
- Cardiovascular instability
- Status asthmaticus
- Marked hypercapnea



BIOPSY



- **BIOPSY**

- Biopsy is the removal of small piece of tissue from the defined part of the body for histopathological examination.

INDICATION

·_Neoplasm

_ILD

BIOPSY

- **NEEDLE BIOPSY**
- **CT- GUIDED BIOPSY**
- **ULTRASOUND- GUIDED BIOPSY**

COMPLICATION

- Bleeding
- Hematoma
- Infection
- Abscess
- Pneumothorax

pulmonary function testing

Respiratory function tests are used to aid diagnosis, assess functional impairment, and monitor treatment or progression of disease. Airway narrowing, lung volume and gas exchange capacity are quantified and compared with normal values adjusted for age, gender, height and ethnic origin.

In diseases characterised by airway narrowing (e.g. asthma, bronchitis and emphysema), maximum expiratory flow is limited by dynamic compression of small intrathoracic airways, some of which may close completely during expiration, limiting the volume that can be expired ('obstructive' defect). Hyperinflation of the chest results, and can become extreme if elastic recoil is also lost due to parenchymal destruction, as in emphysema. In contrast, diseases that cause interstitial inflammation and/or fibrosis lead to progressive loss of lung volume ('restrictive' defect) with normal expiratory flow rates

pulmonary function testing

Measurement of airway obstruction

Airway narrowing is assessed by asking patients to blow out as hard and as fast as they can into a peak flow meter or a spirometer. Peak flow meters are cheap and convenient for home monitoring of peak expiratory flow (PEF) in the detection and monitoring of asthma, but results are effort-dependent.

More accurate and reproducible measures are obtained by inhaling fully, then exhaling at maximum effort into a spirometer. The forced expired volume in 1 second (FEV_1) is the volume exhaled in the first second, and the forced vital capacity (FVC) is the total volume exhaled. FEV_1 is disproportionately reduced in airflow obstruction, resulting in FEV_1/FVC ratios of less than 70%. In this situation, spirometry should be repeated following inhaled short-acting β_2 -adrenoceptor agonists (e.g. salbutamol); a large improvement in FEV_1 (over 400 mL) and variability in peak flow over time are features of asthma .

pulmonary function testing

To distinguish large airway narrowing (e.g. tracheal stenosis or compression) from small airway narrowing, flow/volume loops are recorded using spirometry.

These display flow in relation to lung volume (rather than time) during maximum expiration and inspiration, and the pattern of flow reveals the site of airflow obstruction

pulmonary function testing

Lung volumes

Tidal volume and vital capacity (VC – the maximum amount of air that can be expelled from the lungs after the deepest possible breath) can be measured by spirometry.

Total lung capacity (TLC – the total amount of air in the lungs after taking the deepest breath possible) can be measured by asking the patient to rebreathe an inert non-absorbed gas (usually helium) and recording how much the test gas is diluted by lung gas. This measures the volume of intrathoracic gas that mixes with tidal breaths. Alternatively, lung volume may be measured by body plethysmography, which determines the pressure/volume relationship of the thorax. This method measures total intrathoracic gas volume, including poorly ventilated areas such as bullae.

Transfer factor

To measure the capacity of the lungs to exchange gas, patients inhale a test mixture of 0.3% carbon monoxide, which is taken up avidly by haemoglobin in pulmonary capillaries. After a short breath-hold, the rate of disappearance of CO into the circulation is calculated from a sample of expirate, and expressed as the TLCO or carbon monoxide transfer factor. Helium is also included in the test breath to allow calculation of the volume of lung examined by the test breath.

Transfer factor expressed per unit lung volume is termed KCO